

DIGITAL SUBSCRIBER LINE COMMUNICATION SYSTEM

FIELD OF THE INVENTION

The invention is generally in the field of communication and concerns a system for voice and data communication. More particularly, the present invention relates to a communication system on existing twisted pair telephone cables, utilizing digital subscriber line (DSL) technology.

BACKGROUND OF THE INVENTION

Existing plain old telephone service (POTS), based on a twisted pair telephone cable, is the most widespread communication infrastructure in the world. Technologies have been developed which permit to utilize existing telephone cables for the high rate data transmission characteristics of digital communication. These include digital multitone signal technology that permit to use the twisted pair telephone subscriber lines for multi media and high-speed data communication. Asymmetrical digital subscriber line (ADSL) allows the transmission of data or rate exceeding 8 Mb/s to a subscriber premise, and at a rate as high as 1 Mb/s in bi-directional communication. Such rates expand existing access capacity by 50 folds or more without the need for new cabling. ADSL can transform the existing public telephone network from one limited to voice, text and lower resolution graphics to a powerful, ubiquitous system capable to bringing multimedia, including full motion video, to every home.

An ADSL circuit includes an ADSL modem on each end of a twisted pair telephone line, creating three information channels - a high speed downstream channel, a medium speed duplex channel, and a POTS channel. The POTS channel is separated from digital modems by filters, thus guaranteeing uninterrupted POTS,

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even if ADSL fails. The high speed downstream channels support a bit rate from about 1.5 to about 8 Mb/s, while duplex channels support rates which range between 16 to 1040 kb/s. Downstream data rate depend on a number of factors including the lengths of the copper line, the wire gauge, the presence of bridged
5 taps, and cross cable interference. Line attenuation obviously increases with line length and frequency and decreases as wire diameter increases. A typical ADSL line will transmit at the rate of 1.5 Mb/s, with a wire diameter of 0.5mm, over a 5.5 km and at an 8 Mb/s over a distance of 3.7 km for a wire of the same diameter. For wire with a 0.4 mm diameter, the respective distances are 4.6 km and 2.7 km.

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10 One problem of ADSL systems is the need to rewire existing telephone home networks within a subscriber premise and to place special splitter devices for separating voice and ADSL signal to a subscriber premise. In order to eliminate splitter and rewiring of home networks, a G.Lite ADSL system was developed, in which the separation between the ADSL and the voice signals is realized by means
15 of special microfilters placed serially in the line connecting each home telephone device to the external line. However, the G.Lite system supports a bit rate up to 1.5 Mb/s only in a downstream direction, which is too slow for a variety of applications including, in particular, video-on-demand service. Furthermore the microfilter associated with a telephone device decreases the quality of voice communication.

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20 In multi apartment buildings the telephone lines typically reach a central box and from there telephone lines extend to each of the apartments. In existing systems, such inter-building wiring is also not suitable for high-speed data communication. Typically, such inter-building wiring makes use of flat pair cables, which have unpredictable characteristics and are highly sensitive to RF noise.

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25 Another problem of existing ADSL systems is that a customer must have an ADSL home modem and a personal computer at the subscriber premise. Every home device which requires high-speed data service from a telephone station, such as a video phone, digital TV, hi-fi digital audio, etc., must be connected to an ADSL home modem through a computer, typically a personal computer (PC). In
30 practice this means that a location, to make use of an ADSL system, with intra-

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location network capability, needs two independent networks: an existing telephone network and an additional digital data network.

A further problem of ADSL systems is that only one home modem may communicate with a modem at a central office of the communication service provider at the same time. If a subscriber has several computers, only one of them may thus be connected to the telephone line.

SUMMARY OF THE INVENTION

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In accordance with the present invention a digital subscriber line communication system (DSLCS) is provided, which permits voice and data service to a subscriber premise using existing into and within (intra) building wiring without the need for installing any special communication equipment inside the subscriber premise. Any device in the home requiring high speed data communication from a communication service provider, e.g. a video phone, a digital TV, hi-fi digital audio device, a personal computer, etc., may be connected directly to existing telephone lines inside the subscriber's premise. Subscribing to an ADSL system does not require any laborious installation and in particular the subscriber does not require an ADSL modem and may get some special data services, e.g. for a digital TV or the like, without using a computer.

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In accordance with the present invention use is made of a novel subscriber converter, that links between the twisted pair communication cable connecting to the central office of a communication service provider and the local wiring which leads to the subscriber's premise. The subscriber converter has a splitter-isolator device that POTS-related signals therethrough without attenuation, while converting HPN signals from a subscriber premise to xDSL signals transmitted to the CO and vice versa.

A number of subscriber converters may be placed in a local box serving a group of local subscribers. Typically, such groups of subscribers will be included in a single building which may be a residential building, an office building, etc.

However, the group of subscribers may also be several houses located in a neighborhood connected by local wirings to the local box.

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It should be explained that the term "*local communication box*" or "*local box*" used herein means to denote a central point to which both the subscriber communication line to the central office and the local wirings from the subscriber premise connect. Physically, such a "*local box*" may assume a form other than a box *per se*. It may be housed in more than one casings or at times may not be housed in a casing at all but may rather be included within the framework of a certain facility, within an enclosure, at times together with other equipment.

10 Furthermore, as may also be appreciated, some of the associated devices which are described below as being included within a communication box, e.g. the video server, may at times be physically included as a separate device connected to a box including the subscriber converter.

In accordance with a first aspect of the invention there is provided a communication system, comprising:

- a central office (CO) of a communication service provider with xDSL modems within the CO, each modem being associated with a subscriber;
- a plurality of subscriber premises (SPs), each equipped with one or more telephone devices connected to a telephone line of the SP and one or more devices which can send or receive data over communication lines, the devices being connected to said telephone line by an HPN interface unit;

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- one or more local communication boxes for each group of SPs, each group consisting of one or more SP linked to the communication box by local wirings;
 - a twisted pair subscriber telephone line linking each SP-associated xDSL modem with the local box of said SP; and
 - at least one subscriber converter included within the local box, each of which is associated with one SP that is connected to said box, said converter having a first terminal connected to said subscriber line and a second terminal connected to the subscriber-associated local wiring; said converter comprising an xDSL analog front end (AFE) module connected to said first terminal, an HPN

AFE module connected to said second terminal, a digital xDSL-to-HPN converter module connected to the xDSL AFE and to the HPN AFE and comprising a splitter-isolator module connected to both the first and the second terminals permitting passage there through of low-frequency, POTS-related signals while
5 not permitting passage there through of xDSL and HPN signals.

In accordance with another aspect of the invention there is provided a local network comprising:

- a group of one or more subscriber premises, each equipped with one or more telephone devices connected to a telephone line of the SP and one or more
10 terminal devices, which can send or receive data over communication lines, the devices being connected to said telephone line by an HPN interface unit;

- one or more local communication boxes linked to SPs of the group by local wirings and linked to a central office of communication service provider by twisted pair subscriber telephone lines, comprising one for each SP of the group;

15 - at least one subscriber converter included within the local box, each of which is associated with one SP that is connected to said box, said converter having a first terminal connected to the subscriber line and a second terminal connected to the subscriber-associated local wiring; said converter comprising an xDSL analog front end (AFE) module connected to said first terminal, an HPN
20 AFE module connected to said second terminal, a digital xDSL-to-HPN converter module connected to the xDSL AFE and to the HPN AFE and comprising a splitter-isolator module connected to both the first and the second terminals permitting passage there through of low-frequency, POTS-related signals while not permitting passage there through of xDSL and HPN signals.

25 In accordance with a still further aspect of the invention there is provided a subscriber converter device comprising:

- a first terminal for connection to a subscriber line, which comprises a twisted pair cable linking the subscriber converter to a central office of a communication service provide;

- a second terminal for connection to a subscriber-associated local wiring linking the SC to an SP.
- an xDSL analog front end (AFE) module connected to said first terminal;
- an HPN AFE module connected to said second terminal;
- 5 - a digital xDSL-to-HPN converter module connected to the xDSL AFE and to the HPN AFE; and
- a splitter-isolator module connected to both the first and the second terminals permitting passage there through of low-frequency, POTS-related signals while not permitting passage there through of xDSL and HPN signals.

10 The subscriber-associated local wiring, particularly where the local network is included within a building, is typically constituted from a flat pair cable.

The terminal devices may include a wide variety of devices, which can send or receive data over communication lines. These include personal
15 computers, video devices, television sets, videophones, IP phones, hi-fi audio devices, and others.

For ADSL communication the HPN interface unit is typically an HPNA-2 interface unit and the analog AFE modules as well as a converter modules within the subscriber converter will be adapted accordingly. For VDSL communication,
20 the HPN unit is typically an HPNA-3 interface unit and the subscriber converter will be adapted accordingly.

For a variety of publications the subscriber converters may be associated with a server computer, coupled to said xDSL-to-HPN converter module. The computer server may have an integral or may be linked to a remote digital port
25 for coupling to accessory devices or terminal devices within the subscriber premise, will also be described and exemplified below.

The digital xDSL-to-HPN converter may particularly comprise:

- a first digital signal processor (DSP) for conversion of xDSL signals to digital data packets and for conversion of digital data packets to xDSL signals,

coupled to the xDSL AFE, to a first program memory and to a read and write memory (RAM);

- a second DSP for conversion of digital data packets to HPN signals and for conversion of HPN signals to digital data packets, coupled to the HPN AFE, to a second program memory and to a RAM;
- a data exchange controller coupled to the RAM, to said first DSP and to said second DSP for exchanging data between the two DSPs and between the DSPs and the RAM; and
- a control processor coupled to said first DSP, to said second DSP and to said data exchange controller.

The system and network of the invention may also comprise one or more video servers, typically connected to the digital port of the server computer. The video server may download video films or video broadcasts transmitted from the CO through the subscriber converter and then transmission of downloaded video films or the broadcasts to the subscriber premise through the subscriber converter. The rate of data transmission to the video server, e.g. the time required to download a video film, may at times be accelerated by downloading the data simultaneously through a plurality of SCs to which the video server is associated, which are those not in current use by their respective subscribers. The video server may be programmed to alternatively choose for downloading those subscriber converters not in use and SCs use a subscriber converter once use is commenced by the subscriber.

The video server may also be linked to other data receiving systems including, for example, satellite broadcasts receiving system, a cable TV receiver equipment, terminal receiver device for optical fiber transmission, and others.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

5 **Fig. 1** is a schematic representation of an embodiment of a DSLCS of the invention.

Fig. 2 is a block diagram representation of a subscriber converter in accordance with an embodiment of the invention, useful in the DSLCS of Fig. 1.

Fig. 3 is a block diagram representation of a subscriber converter in
10 accordance with another embodiment of the invention.

Fig. 4 is a schematic representation of a DSLCS in accordance with an embodiment of the invention.

Fig. 5 is a schematic representation of another embodiment of a DSLCS of the invention.

15 **Fig. 6** is a block-diagram representation of a video server device in accordance with an embodiment of the invention.

Fig. 7 is a schematic representation of a DSLCS in accordance with another embodiment of the invention.

Fig. 8 is a schematic representation of a DSLCS in accordance with another
20 embodiment of the invention.

Fig. 9 is a schematic representation of a DSLCS in accordance with another embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is first being made to Fig. 1 showing a DSLCS **101** in accordance
25 with an embodiment of the invention. The system shown in Fig. 1 comprises central office (CO) **103** of a telephone service provider, linked to a multi-apartment building **107** by twisted pair telephone cables **121**, included within cable **105**. CO **103** includes a plurality of xDSL office modems **106** included within the office's xDSL equipment **108** each one connected to one of twisted pair

cables 121. Each xDSL modem 106 is further connected to the telephone network 135 and to data network 137 to provide POTS and data service, respectively, to the subscribers.

Building 107 includes a number of subscriber premises 109, typically each being included in a separate apartment of the building, as well as a local central communication box 123 with twisted pair cables 121 leading into box 123. Box 123 is also connected by a plurality of intra-building cables 111, to each of the subscriber premises 109, cables 111 being typically a flat pair cable (although at times it may also be a twisted pair). The subscriber premise, in accordance with this embodiment, comprises one or more telephone devices 115 (only one shown in the illustration of Fig. 1) and one or more computers, typically personal computers (PCs) 113 (two are illustrated in Fig. 1). Each of PCs 113 is connected directly to a connector 117 of the telephone line 119 through an associated or integral HPN (home phone network) interface device 114. The telephone device 115 is also connected to telephone 119 through a similar connector.

Local box 123 comprises a plurality of xDSL/HPN subscriber converters 125, one for each subscriber premise 109. Each subscriber converter is connected to and links between a twisted pair 121 and an intra-building cable 111.

The structure of an xDSL/HPN converter 125 is shown in Fig. 2. It comprises a splitter-isolator 203, including a high-pass filter 203A, a low-pass filter 203B and an HPN line transformer 203C, linking between an input connector 205 and an output connector 207, an xDSL analog front end (AFE) module 209 coupled to input connector 205 via capacitors 210 of a high-pass filter 203A, an HPN AFE module 211, coupled to output connector 207 via solenoids 212 of transformer 203C and a digital xDSL/HPN converter module 213 coupled to xDSL AFE module 209 and to HPN AFE module 211. A computer server 215 is coupled to converter module 213 and to a digital interface port 217. Input connector 205 and output connector 207 are connected, respectively, to twisted pair cable 121 and to intra-building cable 111.

Communication system 101 provides voice and digital data service to every subscriber premise 109 of building 107. Voice signals from telephone network 135 are routed through a POTS-splitter (not shown) of the CO xDSL equipment 108, into twisted pair cable 121. Data signals from data network 137 are converted to xDSL line signals by the office modem 106 and are then also routed into the same subscriber twisted pair 121. The CO may use standards sDSL equipment like ADSL or VDSL modems and may function in a similar way to that in existing ADSL or VDSL systems.

10 Voice signals from telephone 115 inside the subscriber premise pass through cable 111 and then through splitter isolator 103 of subscriber converter 125, without any attenuation. Data signals from PC 113 are converted to HPN line signals by the HPN interface device 114 and are then converted to ADSL line signals within the subscriber converter 125. The HPN line signals are first converted into a digital form by the HPN AFE device 211 and then pass through the digital xDSL/HPN 15 converter module 213, which through a digital signal processing decodes the digital data which can subsequently be stored within an internal memory of device 213. A unit within the xDSL/HPN converter module 213 reads the data, e.g. from the internal memory, and then, through a digital signal processing converts the data to discrete xDSL signals. The xDSL AFE module 209 then converts the discrete 20 xDSL signals to analog xDSL line signals, which are then transmitted through input connector 205 and cables 121 to modems 106 of CO 103.

Computer server 215, which is optionally provided in some embodiments of the invention, can exchange data with the internal memory of the xDSL/HPN converter device 213 and may store data in its memory, which may subsequently be 25 used by the subscriber. For example, the computer server 215 may be programmed by the customer to store and automatically update internet pages such as news pages, sport information, business information and others. A digital interface port 217 may be used for connection of server 215 to other devices to realize various additional potential features as will be described further below.

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The conversion of line xDSL signals transmitted through cable 121 from the CO, to HPN also takes place within subscriber converter 125, in a similar way, *mutatis mutandis*. Received xDSL signals are converted by the xDSL AFE module 209 into a discrete digital form and is then processed by the digital xDSL/HPN converter module which decodes the digital data. The digital data may be stored in the internal memory of device 213. Another unit of the xDSL/HPN converter module 213 reads the data, e.g. from the internal memory, and then, through a digital signal processing converts the data to discrete HPN signals. The HPN AFE module 209 then converts the discrete HPN signals to analog HPN line signals.

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The DSLCS of the invention has several important features. For one, in installing the DSLCS there is no need for rewiring of existing intra-building wires as in the case of full rate ADSL and there is further no need for microfilters like in the case of splitterless ADSL. Further, the DSLCS of the invention achieves high performance communication with the xDSL office equipment, as it uses the twisted pair telephone cables directly connected to a subscriber converter. This decreases noise and RF interference on the xDSL line, as compared to existing systems, and terminates bridge tapes problems common in a splitterless ADSL.

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Another important feature of the invention is that every PC in the subscriber premise may be connected to the CO at the same time, through the subscriber converter. Furthermore, any device in the subscriber premise that needs high speed data services from a communication service provider, such as video phones, digital TV, hi-fi digital audio and others, may be connected directly to existing telephone connectors inside the premises, with no need to connect such devices, via a computer.

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The computer server of the subscriber converter may support many different applications. For example, the computer server may, in accordance with some embodiments of the invention, replace the subscriber's PC. For this purpose, the subscriber premise may include a terminal device which may execute functions

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such as video phone, personal computer function, internet connection, remote control to different home utilities, and others.

The invention may be realized both with different xDSL standards (e.g. ADSL, VDSL, SDSL, HDSL) and different HPN standards (e.g. HPNA-1,
5 HPNA-2, NDSL).

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Reference is now being made to Fig. 3 showing, by way of a blocked diagram, the structure of a subscriber converter 325 in accordance with another embodiment of the invention. This subscriber converter utilizes ADSL DMT standard for communication with the CO and HPNA-2 standard for intra-building
10 communication. This converter may support a home network communication with a bit rate of up to 10 Mb/s, a downstream bit rate from the CO at up to 10 Mb/s (over a line having a distance of up to 3 Km) and an upstream bit rate to the CO of 1 Mb/s.

Subscriber converter 325 comprises a splitter isolator 403 linking between
15 input connector 405 and output connector 407, an ADSL AFE module 409, coupled to input converter 405, an HPNA-AFE module 411 coupled to output connector 407 and a digital ADSL/HPNA-2 converter module 413 coupled to the ADSL AFE module 409 and to the HPNA-2 AFE module 411. An optional computer server 415 is coupled to converter device 413 and to a digital interface
20 port 417. The input connector 405 is connected to a twisted pair telephone cable 321 connected to the CO and the output connector 407 is connected to flat or twisted pair 311 of intra-building wiring.

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The splitter isolated 403 comprises high-pass filter 421, a low-pass filter 423 and an HPN line transformer 425.

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25 An input ADSL signal from the twisted pair 321 inputs the ADSL AFE device 409 through high-pass filter capacitors 424. Voice signal passes through the low-pass filter 423, having typically band widths of about 8 kHz, and given the fact that the frequency diapason of the voice signal is about 0.3-4 kHz, it passes therethrough without attenuation. Against this, ADSL line signals are allocated in a diapason of about 30 kHz-1.1MHz. the HPNA-2 signals are allocated in a diapason
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of 4 MHz-10MHz. Thus, the low-pass filter 423 has a very high attenuation for ADSL HPNA-2 signals (about 60-80 dB) and thus provides an effective isolation of such signals between input connector 405 and output connector 407. HPNA-2 signals are routed into intra-building wiring 311 through the line transformer 425, which has a very low impedance for voice signals. An output capacitor 427 of low-pass filter 423 has a very low impedance for the HPNA-2 signals.

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ADSL AFE module 409 comprises an ADSL line transformer 429, a line driver integrated circuit (IC) 431 and a ADSL AFE IC 433. Resistors 435 match the impedance of device 409 with impedance of twisted pair 321. Line driver 431 and the ADSL AFE IC 431 may be selected from a variety of such devices known *per se*. ADSL AFE IC 433 comprises an analog receiver filter 451, an analog transmitter filter 453, analog-to-digital converter (ADC) 455, digital-to-analog converter (DAC) 457 and a digital parallel interface (DPI) block 459. The ADSL AFE IC 433 converts the received DMT signal to an output word, and converts an input digital word into an analog DMT signal. The digital word may for example be a 14 bit word. Output digital words are outputted from ADSL AFE device 409 through output bus 463 and input digital words are inputted through input bus 461.

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HPNA-2 AFE module 411 may be selected from a wide variety of available devices known *per se*. The HPNA-2 AFE module 411 comprises a line driver 465, a receiving filter 467, an ADC 469, a DAC 471 and a DPI 473. The HPNA-2 module 411 converts received QAM signals to output digital words and converts input digital words into a QAM signal. The digital words may, for example, be 12 bit digital words. The input digital word is inputted to the HPNA-2 module 411 by input bus 475 and the output digital word is outputted through output bus 477. The digital ADSL/HPNA-2 converter module 413 includes a VSLI circuit. It comprises a first DSP 479, a first program memory 481 loaded with a micro-program for the ADSL signal processing, a second DSP 483, a second program memory 485 loaded with a micro-program for the HPNA-2 signal processing, a data exchange controller 487, a buffer RAM 489 and a control processor 491. The first DSP 479 is

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controlled by the micro-program in first program memory 481 and is coupled to the ADSL AFE device 433 by input and output buses 461, 463. The second DSP 481 is controlled by the micro-program in second program memory 485 and is coupled to the HPNA-2 AFE module 411 by input and output buses 475, 477. Control
5 purser 491 may be coupled to an optional server computer 415, the latter being coupled to a digital interface port 417.

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In operation, QAM line signals from an HPNA-2 interface module associated with a computer in the subscriber premise, is transmitted through the intra-building wiring 311 to output connector 407. Voice signals pass without
10 attenuation through a splitter-isolator 403, in a similar manner as that described in connection with the embodiment of Fig. 2. QAM line signals are converted into a digital form by the HPNA-2 AFE module 411 and then passed to second DSP 483 of the digital ADSL/HPNA-2 converter module 413, which through signal processing decodes the digital QAM signal. The decoded data may be stored in
15 buffer RAM 489. First DSP 479 receives the information data, e.g. reads this data from RAM 489, and through digital signal processing converts this data to discrete DMT signals which are outputted through bus 461 to ADSL/HPN-2 converter 413. Received DMT signals are converted by the ADSL AFE device 409 to analog DMT line signals.

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20 An optional server computer 415 may be provided, coupled to control processor 491 through a digital interface port. This computer server may provide for a variety of different applications, similarly s described above in connection with Fig. 2.

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25 Reference is now being made to Fig. 4 showing a schematic representation of another embodiment of a DSLCS, generally designated 301 in accordance with an embodiment of the invention. A local box 323 comprising subscriber converters 325, of the kind shown in Fig. 3, receives twisted pairs telephone cables 321 and is connected through intra-building wiring 311 to the different subscriber premises 308, 309 and 310. As will be appreciated, although three
30 subscriber premises are illustrated, this is an example only to illustrate some

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different types of subscriber network configurations within a subscriber premise. Subscriber premises 309 is similar to subscriber premise 109 shown in Fig. 1 with the same components designated by the same reference numerals, shifted by 200. The subscriber premises 309 comprises a video phone 354, an IP telephone 355, a regular telephone device 315 and a printer 357. Video phone 354 and IP telephone 355 are connected to telephone line 319 by HPNA-2 interface blocks 314, while telephone 315 is directly connected to line 319. The IP telephone 355, the videophone 354 and the telephone 315 may work simultaneously to provide three voice channels with the CO. There is essentially no limit to the number of IP telephones that may be connected to subscriber line (typically more than 20 units). The videophone 354, may in some embodiments of the invention, work in conjunction with the optional computer server 415, in which case the video phone may support internet service. Also included in subscriber premise 308 is a printer 357 which is linked to line 319 also through an HPNA-2 interface 314 and may again operate in conjunction with the computer server 415.

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Subscriber premise 310 comprises an HD-TV 335, a terminal device 337, a DVD device 341, a digital audio recorder 339, all connected to the telephone line by means of an HPNA-2 interface block 314. Also included in premise 310 is a common telephone 315, directly connected to line 319. Subscriber premise 310 further comprises a wireless set-top box 343 that may control different home devices and mechanisms by means of RF frequency.

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The HD-TV 335 may receive video programs transmitted from the CO, and may also display a video films transmitted from DVD device 341. The terminal device 337 is coupled to and works in conjunction with the computer server of the subscriber converter to replace a home PC and may be used for control of all devices connected to telephone line 319. As may be appreciated, the subscriber converter is continuously in operation and may be programmed by terminal device 337 to monitor other home devices and appliances through the wireless set-top box 343.

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In a premise configuration of the type of premise 310, many services and applications may be obtained without the need for a home PC at the subscriber premise such as, for example, printing newsletters, electronic mail service, fax service, Internet service, and others.

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5 A DSLCS 601 in accordance with another embodiment of the invention is shown schematically in Fig. 5. In this figure, like components to those of Fig. 1 were given like reference numerals shifted by 100, and the reader is referred to the description of Fig. 1 for explanation of their nature and function. Building 307 of this embodiment comprises, within box 323, a video server 375 linked through
10 interface cable 379 to interface ports 380 of subscriber converter 325. HD-TV set 335 comprises a MPEG decoder 351 and an HPNA-2 interface device 314, linked, through socket 317, to telephone line 319. Data network 337 is linked to a video-service provider 302. Video server 375 permits a customer a video-on-demand service, a video-library service as well as other database service.

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15 One embodiment of a video server 375 is illustrated by block diagram, in Fig 6. Video server 375 comprises a large size memory 501, coupled to a memory controller 503; a host processor 505; a plurality of subscriber channels, one for each subscriber converter, each comprising a buffer RAM 509 linked to memory 501 by means of bus 511, each buffer RAM being coupled to an interface controller 507
20 which is in turn connected to interface cable 379; high speed interface ports 513 and 517, both connected to a demultiplexer 515 and coupled to the host processor 505; and a plurality of RAMs 519, one for each subscriber converter, coupled to memory 501 by means of bus 521.

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25 The host processor controls the different devices or modules of a video server 375 and is controlled by a program which may be loaded from a floppy disk, from a CD ROM, etc., or from the CO, channel 201 of the subscriber converters. The host processor may be directly coupled to devices within the subscriber converter for control of their operation, and may also communicate with the office xDSL modem, at the CO. The host processor supports video-on-demand service
30 and video library service for each of the customers linked to local box 323. The

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high speed port 513 and 517 as well the as demultiplexer 515 are useful for a connection to external devices, as will be described below with reference to two applications, video on demand service and video library service.

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The DSLCS of Fig. 5 provides video-on-demand service, e.g., as described in the following. A customer may access computer server 415 either from a PC 313 or from a terminal device 337 and may order a video film, e.g., by sending to the host computer an Internet URL code. Video server 375 then establishes communication with video-provider 302. The video film may be transmitted by data packets with a bit rate, for example, 1.5 Mb/s by using ADSL downstream communication protocol or at a higher rate by the use of VDSL protocols, as available. Each data packet includes an ID number that comprises information about the transmitted film and the serial number of the packet. The received data packet transmits through interface port 380 to video server 375. The interface controller 507 then rights the data packet into buffer RAM 509. The host processor reads the ID number of the data packet stored in each buffer RAM 503 and then rights the packet into memory 501 together with the ID numbers to eventually produce a video film file. After the end of the transmission, the host processor may insert the name of the file into a catalog and send a message to the customer. The film may then be accessed by the relevant subscribers. The film may be retrieved from the memory and then transmitted to HD-TV 335 through HPN interface 314 and decoder 351.

The loading of the film may conveniently be done during off-peak hours. As will be appreciated, memory 501 may be used for storage of data files other than video films. For example, each subscriber may assign a part of the memory for storing a backup for his PC as well as for any other data or programs.

Video library service may be realized in a similar manner. The video provider 302 may periodically send to a subscriber newly released films.

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Fig. 7 illustrates a DSLCS 801 in accordance with another embodiment of the invention. Most components of the system are the same to those of Fig. 5 and the reader is referred to the relevant description below for understanding of their

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nature and function. A DSLCS 801 in accordance with this embodiment comprises a satellite antenna 369, typically placed on the building's roof, and connected by a coaxial cable 365 to a TV satellite receiver 367, placed inside the local box 323. Satellite receiver 367 is associated with an MPEG coder 361 and a multiplexer 366, connected to video server 375 by means of length to video server 375 by means of a coaxial cable 378. An interface cable 381 connects receiver 367 to an interface port of video server 375. In this embodiment, the customer has the choice of ordering a broadcast, a video, etc., through satellite communication in addition to his ability to obtain such service through the CO 303. Furthermore, satellite communication may also be used in this embodiment for a variety of other services including, for example, Internet services.

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Fig. 8 illustrates a DSLCS 901 in accordance with another embodiment of the invention, which additionally supports also cable TV. In this figure, like components to those of Fig. 7 have been given like reference numerals and the reader is referred to the description above for explanation of their nature and function.

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A cable TV receiver 383 is included within local box 323 and is connected to different cable TV providers 304, typically by coaxial cables 385. Each cable TV receiver 383 is connected to a multi-channel MPEG coder 387 which is in turn linked to multiplexer 366, connected to video server 375. The system 901 provides data in both services from the CO, TV satellite broadcast services and cable TV service, all of which can be accessed by the customer through his HD-TV television set 335 with its associated decoder 351 and HPN interface block 314.

A36
CONT'D

Another embodiment of a DSLCS of the invention is shown in Fig. 9. System 1001 of this embodiment includes various components included in embodiments described above and the reader is referred to the above description for explanation of their nature and function. In the system of embodiment 1001, included in local box 323 is a fiber optical receiver 91 connected to an optical cable 393 to a high speed data service provider 395 and through high speed data link 378 to high speed interface port of video server 375. In order to realize high

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CONCL₅

As will be appreciated, the specific embodiments described herein are merely an example and a large number of changes, or variations are possible, all being clear to the man of the art, all encompassed within the invention as defined herein. The above description is thus an illustration of the full scope of the invention and does not intend to be limiting.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	